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Tactual Discrimination of Forms

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Louisville, Kentucky

JUN 7 1973

Abstract

Tactual discrimination of forms involving elementary understandings of spatial relationships was examined in sighted, partially sighted, and blind students enrolled in either public or private schools as of September 1977. Each subject was seen individually and was presented familiar household objects, school objects, and geometric shapes cut from masonite board. The subject tactually examined each object or shape behind a screen. Initially, the subject was required to find an object identical to the stimulus while in the second part the child chose an object similar in function to the stimulus. After the geometric and topological shapes were tactually examined, the subject was instructed to choose a shape identical to the stimulus from a collection of shapes.

Developmental trends for these tactual discrimination skills were examined by considering differences between those with one year of school experience and those with no previous schooling. Comparisons of the performance of the present subjects with those of Larendeau and Pinard (1970) on recognition of shapes indicated a similar order of items when ranked by relative difficulty. No differences were found on the basis of the amount of vision or of sex.

Suggestions on earlier drafts and assistance in preparation of figures and tables by Anthony Siegel are gratefully acknowledged.

TACTUAL DISCRIMINATION OF FORMS

INTRODUCTION

In recent years attention has been increasingly drawn to the problems of reading and interpreting tactile displays, particularly tactile maps, for visually impaired persons. These studies have examined the concrete aspects of discriminability of symbols, size of displays, production techniques for tactile displays as well as more abstract aspects such as manipulative techniques involved in reading and the organizational outlines inferred from this reading. An area that has remained relatively unexplored, however, is that of the development of those concepts which are necessary for interpretation of tactile displays. The studies presented here are initial experiments in an anticipated series of studies designed to identify and examine some of these concepts.

To determine areas to be examined, the tactile display, specifically, the tactile map, and its use by the visually impaired individual needs to be considered. A map is defined (Guralnick, 1970) as a drawing or other representation, usually on a flat surface, of all or part of the earth's surface or any maplike representation or delineation. A tactile map then, is a representation on a flat surface of all or part of the earth's surface that may be perceived or read through the tactual sense. It is a two-dimensional model of some aspect of the individual's three-dimensional world. Therefore, to identify the skills and abilities necessary to interpret tactile maps, the investigator must understand how the blind individual first interprets his three-dimensional world. Since this involves the relationships of objects in space, the present studies and those to follow are an attempt to identify various aspects of the young blind child's developing concepts of space, spatial relationships,and their mental representations.

REVIEW OF LITERATURE

In Hatwell's (1966) study of Piagetian reasoning and blind children, she reviewed the early theories of both philosophers and psychologists with respect to the ideas of space and its relation to blindness. To develop their ideas, these early researchers attempted to delineate the relationship between visual and tactual perceptions. Two approaches were used. Either they studied the congenitally blind immediately after sight was restored by surgical means, or they compared the tactual performance of congenitally blind individuals with that of temporarily blinded persons, usually by blindfolding the sighted. Both of these approaches had limitations. In the first, early references were made to adults whose sight was restored. However, in light of more recent research, this seems improbable for two reasons. First, eye conditions ameliorable to surgical intervention are performed at very early ages, as early as 6 months and no later than between 2 and 4 years of age (Bouzas, 1955). After this age, functional recovery is considered questionable. Secondly, much research has been conducted indicating the permanent deleterious effects of the lack of sensory stimulation during the early years of infancy.

The second approach was limited by the fact that although blindfolded, the sighted were not equivalent with their blind counterparts because they still possessed memory for their visual concepts and experiences.

As these early scientists examined their results, conclusions differed widely. Locke (1690) felt the blind had ideas of space which they learned as well as the sighted. What was missing was the connection between cues learned through tactual perception and those cues learned after sight was restored. To him, visual appearance was not the essential aspect of spatial perception. In 1704, Leibnitz reasoned that as a form of abstraction,

geometric space did not need visual imagery. This position was reinforced by the findings of Saunderson, a famous blind geometrician. Berkeley (1709) held that eyesight and touch were opposite modalities and only touch which required direct contact with objects lead to the notion of space. Vision, itself, carried no spatial cues.

By 1785, however, Platner concluded from his observations of a blind individual that only sight lead to a notion of space since only sight permitted simultaneity of perception. Tactual perception which proceeded successively to explore an object, was temporally distributed and could not have a spatial nature. The blind substituted time for space and, therefore, were unable to construct space or achieve a notion of space.

Continuing in this vein, Hagen (1844) deduced that touch did not permit spatial discrimination. To support this judgment he cited the fact that the ability, in itself, did not identify the exact location of a stimulus. Rather, vision was necessary to correlate with the tactual sensations and this was accomplished only through continued practice. His example stated that when two points were touched on the skin, the individual did not feel information regarding how far apart they were. Instead, the points had to be first visually located and then the distance measured by the imagination which engulfed the entire body to determine the relationships. Hagen concluded that this was the process for all estimations of tactual dimensions. The research of Gelb and Goldstein in the 1920's continued to support the idea of the predominant role visual representations played in the tactual perception of forms. Von Senden (1932) in further agreement with Platner and Hagen decided from his review of research that the spatial concepts of the blind were intellectual constructions without sensory foundation. He found no reason to accept the notion of a tactual space.

Steinberg (1920) using the distinction of near space, extended space, and still more extended space introduced in 1895 by Heller determined that the only method totally available to the blind was near space. This was defined as that which could be embraced by only one hand or by both hands close together. Extended space, which could be explored by using both arms was concluded difficult to comprehend without the use of sight. The third category (still more extended space) called for displacement of the subject and was not employed by the blind.

In his extensive work, Révész (1950) found nothing in common among the visual, tactual, or auditory worlds, but that correlations between visual and haptic (tactilo-kinesthetic) perceptions were progressively established because they both dealt with the spatial nature of exterior objects. Although he conjectured that haptic perception was autonomous and governed by specific laws not necessarily applicable to visual perception, Révész conceded a notion of space to the blind, although it was different from that of the sighted.

From animal studies the importance of early stimulation was learned. In his studies of rats, Hebb (1947) found that visual "gestalts" were formed during the first months of life. Deprivation of visual stimulation impaired their subsequent establishment. Riesen (1947) observed that chimpanzees who were raised in darkness until 8 months of age were inferior in visual discrimination. Therefore, he concluded that lack of visual stimulation in infancy affected the structure of receptors and nervous optical paths which was irreversible if the effects were prolonged. This suggested that the need for early stimulation of sensory organs is vital if they are to remain organically sound.

Research aimed at understanding the spatial notions of the blind has gone primarily in two directions (Juurmaa, 1972). First, efforts have been made to discover how mobility of a blind individual could be improved by various technical mobility aids. Second, attempts have been made to discover how spatial relationships are or can be mastered on the basis of sense data other than vision without technical aids. The first approach, Juurmaa (1972) concluded, was of great importance and was followed at present in numerous studies. In contrast, the second approach was potentially of utmost theoretical and practical importance, but at the time of writing had received attention only rarely.

Conceptual research has suggested that blind children do not understand what they encounter and, therefore, primarily function on concrete or functional levels. In the tactual realm, recognition of form amounts to successive operations with spatial relationships; that is, a tactual gestalt is always a successive gestalt (Boldt, 1969; Hatwell, 1966; Juurmaa, 1967; Kephart, Kephart, & Schwartz, 1974; Zwibelson & Barg, 1967).

Most extensively studied has been the relationship between spatial perception, spatial representation, and mobility (Clarke, Pick, & Wilson, 1975; Foulke, 1971; Juurmaa, 1972; Schulz, 1972; Swallow, 1973; Worchel, 1951). Although the blind pedestrian negotiates the environment with a relative paucity of information, discrimination is basic to the conceptualization of the relationships. The sense of an object at a distance or moving around it without touching it has given rise to the term "facial vision." Research has indicated auditory input is necessary for obstacle detection, and in addition, temporal clues, such as separately perceived echoes and spatial clues as acoustic images of both short and long delays supplement the auditory information. In one study of obstacle detection (Clark, Pick,

& Wilson, 1975), the results seemed to indicate that blind people, although accurately detecting the presence of an obstacle, do not have a clear idea of its distance if its size is unknown. Therefore, they were unable to build up an accurate mental map from a single "viewpoint." Yet they concluded explicit training in echolocation using an aid might be of use to many blind individuals. Since spatial concepts are internalized actions, the blind child could benefit from early training in how to investigate objects actively, how to trace edges, how to feel the entire surface in order to construct an image, and in general, to be more sensitive to various stimuli in the environment. In other words, more emphasis should be placed upon sequential growth and development of spatial concepts for visually limited children (Schulz, 1972; Swallow, 1973; Swallow & Poulsen, 1972.

A comprehensive study of space perception and orientation in the blind and sighted was conducted by Worchel (1951). In the evaluation of the ability of the blind to perceive tactual form, the sighted were consistently and significantly superior to the blind when asked to reproduce or describe the tactual form, but vision was apparently of no importance in tactual form discrimination when tested by recognition alone. This was also concluded by Ewart and Carp (1963) and Ahmad (1971) who found that visual imagery was not necessary for the recognition of forms. Description of form did seem to fall into a pattern, however, when those who lost sight later in life resorted to visual imagery for drawing, describing, or selecting the form (Worchel, 1951).

When testing tactual space relations, the ability to solve spatial problems requiring perception of form and imaginal manipulation of spatial cues (Worchel, 1951), the sighted were again significantly superior over the blind. The hypothesis that visual imagery was a factor in spatial relations was confirmed.

The ability of totally blind to orient themselves spatially and the role of visualization in spatial orientation was also examined. Sighted performance was found significantly superior to the performance of blind subjects, but apparently both the blind and sighted estimated distances by estimating duration of movement. Therefore, Worchel (1951) concluded that in the absence of auditory cues, the blind relied primarily on time for distance estimation while the sighted used both time and visual imagery cues based on kinesthetic cues for estimating distance and direction.

Theoretical explanations of spatial concepts, their development and mental representations have been proposed by several psychologists. To process the information by which an individual constructs models of the world, Bruner (1964) theorized three conceptual systems: enactive representation which was created through action, iconic representation which was built through imagery, and symbolic representation which was developed through language. These modes of representation were acquired in the stated order, each depended on the preceding one for its development, yet all remained intact throughout life. Growth, therefore, depended on the emergence of two forms of competence: First, the child had to acquire ways of representing recurrent regularities in the environment, and second, the child had to transcend the momentary by developing ways of representation and integration. Based on this theory, Bruner (1964) concluded that children who primarily used iconic representations were more highly sensitized to spatial-qualitative organization of experience and less so to the ordering principles governing such organization. This form of representation would seem to be the most difficult to develop in blind individuals based on the previous studies of spatial imagery in the blind.

Piaget drew conclusions similar to Bruner in relation to his theory of

cognitive development in young children (Copeland, 1974; Flavell, 1963; Kamii, 1971; Lovell, 1971; Piaget, 1967; Piaget and Inhelder, 1956; Sauvy & Sauvy, 1974). The child learns about the nature of matter by acting on objects and observing and systematizing these actions and the resulting reactions. The child's first notions of space are formulated as he adjusts actions to reach near or distant objects. Ideas of time are extended as those movements are accommodated to catch a swinging toy (Lovell, 1971).

In the extensive study The Child's Conception of Space (Piaget & Inhelder, 1956) the groundwork for much recent research in this area was laid. For Piaget (Hatwell 1966) mental space was a construction built by the activity of the individual. The construction, which progressed by genetic stages, was not a simple prolongation of perception. It was the coordination of actions which lead to objective space. By nature this co-ordination was intellectual and logical. The elaboration of spatial representation depended more on cognitive processes than on purely perceptive ones.

Space, itself, was defined by Sauvy and Sauvy (1974) in two ways: first, vastness, space travel, extending out from earth's surfaces, or wide open vistas; second, usually associated with some activity described by such phrases as "save me space," "watch this space," "make space for me," "space out the plants," etc... In each of these definitions, space was associated with emptiness and yet implied the possibility of movement (Sauvy & Sauvy, 1974). With vision space can be given parameters that confine it. But for the blind individual the emptiness may be an undefined void.

Piaget's (1956) work with young children found that, unlike mathematical development of spatial concepts, notions of space in young children began with topological understandings and proceeded into projective and Euclidean

concepts. His studies attempted to examine how the child represented space, not how space was perceived. The first topological spatial relation to develop was proximity or "nearby-ness." The younger the child was, the greater the importance of this property. As the child grew older, he became better able to "separate" or distinguish one object or parts of an object from another. Building on the notions of proximity and separation, the child developed the property of order. Finally, the spatial relation of enclosure or surrounding was recognized. An element was not only between or enclosed by other elements in a series, but was also enclosed or surrounded by other elements. Most of these ideas were not integrated into a stable operational system, however, until 7 years of age (Bass, 1975; Copeland, 1974; Flavell, 1963; Piaget & Inhelder, 1956; Sauvy & Sauvy, 1974). The exception was the spatial relation of continuity which involved the notion of infinity. It was not mastered until the formal level of thought (Flavell, 1963). The projective and Euclidean properties achieved equilibrium usually between 9 and 10 years of age (Copeland, 1974; Flavell, 1963; Piaget & Inhelder, 1956).

Replication studies generally supported Piaget's findings but with additional qualifications. Bass (1975) found socioeconomic climate of school significantly influenced development of topological concepts while in a study of the concept of limit at the 12 year age level, only male responses rated in the highest performance category suggesting a sex influence (Mitchelmore, 1976; Taback, 1975). A study of cognitive maps (Hardwick, McIntyre, & Pick, 1977) in sighted children and adults suggested that adult cognitive maps were multilevel representations of spatial information. One level was identified as the general level which contained simple coordinated representations which held between objects in the cognitive map. Another level was a specific

level which contained a series of smaller representations which were associated with particular points of view within the total cognitive map. These levels corresponded to an overall "room map" and a series of several "perspective maps." Piaget found the 8 or 9 year old child was not able to describe a neighborhood as a whole because landmarks were placed in subgroups based on the number of independent vantage points the child used. Likewise, Pick (Hardwick, McIntyre, & Pick, 1977) found young children did not represent the spatial layout of their homes in unified fashion, but concluded that the young child may possess an adult-like cognitive map with both general and specific levels of representation, yet may simply be unable to manipulate it.

As a result of research with sighted children regarding spatial concepts, some teaching and training methods have been suggested (Copeland, 1974; Kamii, 1971; Lovell, 1971; Sauvy & Sauvy, 1974). One approach suggested four instructional objectives for structuring space (Kamii, 1971). First, the child must grasp the notions of "in-out," "over-under," "in front of-in back of," etc. These concepts must be handled not only concretely with the child's own body, but also on a representational level with toys, pictures, and finally words. The second objective, linear order, involves the ability to coordinate proximity relationships to copy placement of objects; first, in precisely the same linear arrangement; second, with the objects to be copied either grouped closer together or spread farther apart than those of the model; and third, in inverse order. Spatial transformations such as the ability to cut a whole shape into many parts and to put it back together constitutes a third objective. The final objective is to reconstruct sensory-motor knowledge of space on a representational plane. In his book, Copeland (1974) describes each assessment which Piaget used in examining the child's notion of space.

Then he suggests ways a teacher may conduct similar experiments in the classroom, how the results may be interpreted and presents classroom activities to promote development of these ideas. Sauvy and Sauvy (1974) analyzed the child's environment to identify games such as hopscotch and other activities that support spatial concept development. Based on this information, the authors also suggest additional activities that parent or teacher may use with a child. Yet similar research with blind children is lacking. Knowledge of the blind individual's concepts regarding space and how that space is organized or mentally represented is not considerable and, generally, inconclusive. In the tactual realm, the individual recognizes form by successive operations (actions) within the restraints of various spatial relationships. To form a judgment on the basis of these operations, the person must tactually observe, systematize the actions, and finally, merge the resulting reactions. Applications for training these abilities in blind children are nonexistent.

PURPOSE

Recognizing the lack of available information on the development of spatial concepts in the young blind child, the present study attempted to identify areas in which further research might prove profitable. Based partially on the previously cited work of Piaget (Piaget & Inhelder, 1956), the study examined topological understandings of young visually impaired children. Common household objects (Nolan & Morris, 1960) were employed initially while various shapes utilized in a study by Larendeau and Pinard (1970) were used in the second part. It was hypothesized that involving both concrete objects and abstract shapes would reveal aspects of elementary spatial concepts in young blind children.

METHOD

Subjects. Subjects were children enrolled in both public and private school classes as of September 1, 1977, who had no severe handicapping condition (with the exclusion of visual impairment), who had had either no previous school experience or only 1 year of schooling, and who were between the ages of 4 to 7 years. Table 1 presents a summary of the sample. Although it was originally planned to assess eight subjects for each cell, difficulty in locating blind subjects who met the sampling requirements necessitated a reduction in sample size. One aspect of this problem proved encouraging. The lower limit of 4 years of age was set because the experimenter from past personal experience had doubted the availability of blind children below this age. In contradiction, it was found that recent emphasis on early education has benefited blind children. Children below the cutoff age of 4 years were located in school programs and blind children above 4 years of age often already had been enrolled in a formal educational program for 2, and sometimes more, years.

Table 1

Sample Distribution for Tactual Discrimination of Forms Study

N = 48

	No previous schooling ages 4 to 7 years		1 year previous schooling ages 4 to 7 years	
No useful vision (blind)	M	4	M	4
	F	4	F	4
Some useful vision (partially sighted)	M	4	M	4
	F	4	F	4
Useful vision (sighted)	M	4	M	4
	F	4	F	4
		24		24

Sighted subjects were randomly selected from kindergarten and first grade classes in a Philadelphia Public School. Blind and partially sighted subjects were selected from classes in the Philadelphia area including Southern New Jersey; Delaware; Montgomery County, Maryland; Indiana School for the Blind; Kentucky School for the Blind; Cleveland, Ohio Public Schools; and Nebraska.

Because of the difficulty in locating blind subjects who met age and prior school experience requirements, it was feared that differences between groups on the basis of age might cause difficulties. Therefore, a series of t tests were used to determine if significant differences resulted between ages the subsamples due to sampling. Table 2 indicates that no significant differences were found between any of the groups.

Table 2

t Test Comparisons between Ages in Months of Tactual Discrimination of Forms Study Subsamples

	0 years previous schooling		1 year previous schooling	
	$\bar{X}$	t	$\bar{X}$	t
Blind	69.13		73.13	
Partially sighted	67.38	.26	76.63	.61
Blind	69.13		73.13	
Sighted	66.00	.83	75.00	.37
Partially sighted	67.38		76.63	
Sighted	66.00	.25	75.00	.53

Materials. The Household Object Familiarity Assessment (HOFA) based on school readiness tests and studies utilizing household objects with young children consisted of two parts. Objects representing six rooms in a house (utility room, living room, bathroom, kitchen, bedroom, and playroom) and three levels of familiarity (very familiar, familiar, unfamiliar) for preschool

children were used to ascertain the young child's ability in Part A (to tactually discriminate the same object as the stimulus object among three choices) and in Part B (to discriminate among three objects an object similar to the stimulus).

The Topological Shapes Assessment (TSA) used to study the young child's reasoning about topological and Euclidian understandings of space were those utilized by Larendeau and Pinard (1970). These were cut from 1/4 inch thick masonite in the dimensions described in the Larendeau and Pinard study (1970). Part A involved simple, more familiar shapes while Part B contained more complex shapes involving greater differentiation between topological and Euclidian understandings (See Figure 1).

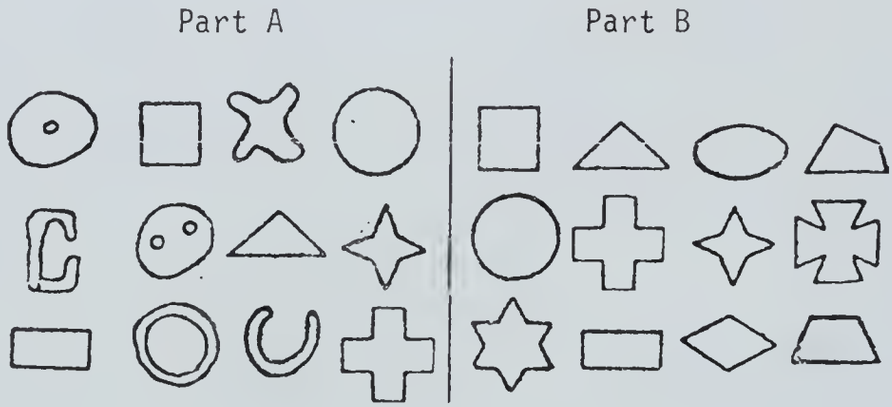

Figure 1

Topological Shapes Assessment

Procedure. Each subject was seen individually for two periods of approximately 30 minutes each. A preliminary task was initially given each subject to acquaint him/her with the procedure to be used in each assessment. This was done without the screening box used during testing of the HOFA and TSA. An additional use of this task was to ascertain whether the child knew the concepts of same versus different. If he/she did not, the tasks were used to teach the concept. Only when the experimenter was satisfied the child

understood the concept (criterion: 3 out of 4 on procedure 1; 4 out of 5 on procedure 2; 3 out of 4 on procedure 3), was that child included in the sample. (Only one child was excluded for failure to reach criterion.) Following the preliminary task and prior to initiating testing, the screening box was introduced and the subject was given opportunity to familiarize himself/herself with it. A three-sided box was used with each subject for both assessments. The front panel of the box contained two cloth sleeves through which the child placed his/her hands. The experimenter, who sat opposite the subject, presented the stimulus object to the child for tactual exploration. Following this presentation, three objects were placed in a divided tray within the screening box for tactual exploration. Part A of the HOFA required the child to identify (point, pick up, state, etc.) which of the three objects was identical to the stimulus. For Part B the child identified the object which was similar ("like it," "same kind of thing," etc.) to the stimulus object, but differing in size, shape, texture, or other principal characteristic.

The procedures for both parts of the TSA were the same. A stimulus shape was presented the child through the screening box to be tactually explored. Four alternatives were placed in the divided tray from which the identical shape was selected.

Design. To create HOFA a preliminary item pool was obtained from school readiness tests (Metropolitan Readiness Test, 1969; Boehm Test of Basic Concepts, 1971), from published research articles (Nolan & Morris, 1960; Piaget & Inhelder, 1956; Thomas, 1971; Weiner, 1963), and from staff members with experience with young children. Three staff members were then asked to rate objects in terms of their familiarity (very familiar, familiar, unfamiliar) to a preschool child and as to the room (utility which encompassed

items from the workshop, sewing, and laundry areas of a house; living or family room; bathroom; kitchen; bedroom; and playroom) in which the object would most frequently be found. Based on these ratings, 15 objects for each room were identified. These were subdivided into three groups based on the categories of familiarity. When an object was assigned to more than one room (e.g., telephone, book, etc.) to ensure an adequate number of choices an additional object was included in the list for that room and familiarity category.

In the next step the items were prepared for parent rating and staff members judged the appropriateness of both format and directions. When revisions were completed, the rating scale was distributed to volunteer parents in the Louisville, Kentucky metropolitan area. A total of 10 parents of sighted preschoolers and 5 parents of visually impaired children responded. They were asked to check the column which they thought best described how their preschoolers would respond (based on familiarity). The last section listed items duplicated in more than one room and asked each parent to designate in which room his/her child would be most familiar with that object.

A tally of ratings was made for parents of sighted and parents of visually impaired children. Finding few differences between the ratings of each group (in fact, parents of visually impaired children frequently rated one level above parents of sighted children), a mean was obtained for the total responses on each object. This mean was used to rank the objects from the most to least familiar. In some room groupings (e.g., playroom) all objects were rated relatively high with regards to familiarity while other rooms (e.g., utility) created a wider dispersion of objects.

From the ranked list of objects for each room, the highest two items representing the very familiar category became the stimulus objects representing that category on Parts A and B of HOFA. The two lowest ranked objects represented the unfamiliar category while the two objects ranked in the medial position were categorized as familiar for HOFA.

Alternatives for each object were chosen from the remainder of the lists. A score of 1 was assigned to the correct option; 2 represented the object in the next closest ranked order (for the very familiar category, this would be the third and fourth objects on the list since one and two were stimulus items for Parts A and B, respectively); and 3 designated the object from the list that could be associated with the stimulus object or in some way might be tactually confusable with it. A table of random numbers was used to order the presentation of the alternatives for each stimulus and to arrange the order of questions for Parts A and B. Through a brief pilot test it was determined that the length of HOFA was too long for young children. Therefore, three items were dropped (one for each category of familiarity) from both Parts A and B. These items generally contained objects either difficult to obtain, extremely cumbersome for assessment and/or transporting, or of relatively high cost (e.g., globe, lightbulb, electric shaver). Also, the original HOFA had contained four alternatives, but was reduced to three options to reduce the time. This decision was based on recommendations for testing young children found in Anderson, Ball, and Murphy (1975).

The construction of the TSA was considerably less involved than that for HOFA. Review of other studies utilizing tactual discrimination of shapes (Bass, 1975; de la Pena, Hirsch, & Eisenson, 1973; Dershowitz, 1973; Larendeau & Pinard, 1970; Piaget & Inhelder, 1956; Schneiderman, 1971), suggested that the extensive work accomplished by Larendeau and Pinard (1970) provided a guide

for the development of TSA. Shapes utilized by these authors were recreated in 1/4 inch masonite. However, unlike their study in which the subject tactually explored a stimulus and then visually searched for its counterpart among the 12 options, the present study presented both stimulus and options tactually. This was necessitated because of the visual impairment of part of the sample. Since to tactually explore 12 options for each stimulus would have been a mammoth task for these young children to undertake, four options were chosen for each stimulus. As with HOFA, 1 designated the correct option, 2 was defined as a topologically similar shape, 3 was termed a distractor shape which often contained similar configurations as the stimulus (e.g., stimulus - option), and 4 represented an object considered to contain properties opposite or distinctly different from those of the stimulus (e.g., stimulus - option). The order of both options and of items was randomly assigned using a table of random numbers.

The assessments were administered in two sessions. The first session was usually slightly longer since the preliminary task was conducted first. This informal task gave the examiner opportunity to develop rapport prior to administration of Parts A for HOFA and TSA. During the second session Parts B of HOFA and TSA were presented.

Data was gathered on a pass-fail basis for recognition or nonrecognition of an object. Analysis of variance techniques were used to address several questions. Piaget (1956) and others have suggested that tactual skills involved in recognition activities for spatial concepts are developmental and not necessarily taught. Therefore, one variable examined was whether school experience affected performance on HOFA. Other studies (Mitchelmore, 1976; Taback, 1975) had suggested that differences in spatial concepts existed between males and females while vision has been acknowledged as an obviously

important variable in development of spatial understandings. An ANOVA was performed to determine the effect of these three variables (prior school experience, differences between sexes, and amount of vision) on the tactual recognition of household objects. No significant differences were found between the sexes, so the groups were collapsed and additional analyses were performed to ascertain the effects of prior school experience and amount of vision on the (1) type of identification required (identical, or similar), (2) room classification from which the objects were drawn (utility, living room, etc.), and (3) the degree of familiarity of the object to young children based on parents' ratings (very familiar, familiar, unfamiliar). Item difficulty was examined by compiling the percentage correct for each item for the sample by vision categories. Although not identified initially as a variable, it was found that many children spontaneously provided a verbal label for the objects. This data, though not adequate for statistical analysis, was examined for possible clues to future research avenues.

Several types of analyses were performed on the TSA data. Initially, analysis of variance techniques were applied to find whether there were differences between the three variables of degree of vision, amount of prior school experience, and sex in the ability to identify first simple and then more complex shapes. Relative difficulty was determined by compiling the number of successes for each shape for the sample by vision categories and by school experience categories. Since four options were included for each item, the defined options were examined to determine the type of errors the subjects made in choosing a shape identical to the stimulus. This was accomplished by tallying the number of choices made for each item by each vision group and by each level of school experience. Since the children frequently gave verbal labels to the shapes, these too were examined to obtain suggestions for future research.

RESULTS

The means and standard deviations for each subsample for total correct scores on HOFA are presented in Table 3.

Table 3

Total Correct Responses by Subsamples on HOFA

		0 yrs. schooling ages 4 to 7 years		1 yr. schooling ages 4 to 7 years		Total by vision	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Blind	M	25.25	2.88	26.50	2.38	25.88	2.57
	F	26.25	1.71	26.50	3.87		
Partially sighted	M	24.50	3.00	28.25	.96	26.06	2.54
	F	26.50	2.38	25.00	2.31		
Sighted	M	26.75	.50	26.75	.50	26.88	2.197
	F	25.25	3.86	28.75	.50		
Total by schooling		25.75	2.45	26.79	2.34		
Total by	M	26.33	2.14				
	F	26.21	2.72				

As may be observed all subsamples obtained relatively high means (maximum attainable score = 30), suggesting that the objects were far more familiar to young children than had been indicated by parents' ratings. It may also be noted that little difference is seen among the various subsamples. The statistical analyses tended to support these preliminary judgments.

A 3 x 2 x 2 analysis of variance was performed on the total correct scores obtained on HOFA (Table 4). As previously concluded, no significant differences were found in performance on the basis of amount of vision, years of school experience, or sex. Since sex differences did not exist the data were collapsed on that variable. Amount of schooling was utilized in the subsequent analyses because it did produce the strongest though nonsignificant

relationship to object identification and because formal educational training has been and is assumed to promote conceptual development. Previously cited research overwhelmingly emphasized the importance of vision in development of spatial notions. Therefore, this variable was utilized in the succeeding analyses.

Table 4

ANOVA on Mean Total Correct Responses on HOFA

N=48

Source	SS	df	MS	F
Vision (A)	9.04	2	4.52	.76
Schooling (B)	13.02	1	13.02	2.20
Sex (C)	.19	1	.19	.03
A x B	4.54	2	2.27	.38
A x C	1.62	2	.81	.14
B x C	4.69	1	4.69	.79
A x B x C	39.12	2	19.56	3.30
Error	213.25	36	5.92	

An additional 3 x 2 x 2 analysis of variance was performed to determine whether young children performed significantly differently when required to locate an object identical to the stimulus (Part A) or one that was similar to the stimulus (Part B). Results may be found in Table 5. A graphic representation (Figure 2) indicates that finding the same object as the stimulus was easier than locating an object similar to the stimulus. Surprisingly, no significant differences were found between vision groups. In fact mean performances on the basis of vision and of school experience were nearly equivalent.

Table 5

ANOVA on Mean Total Correct Responses for Method of Identification (Identical-Similar) on HOFA N = 48

Source	SS	df	MS	F
Vision (A)	4.52	2	2.26	1.03
Schooling (B)	6.51	1	6.51	2.96
Identification (C)	78.84	1	78.84	35.82**
A x B	2.27	2	1.13	.52
A x C	3.06	2	1.53	.70
B x C	.51	1	.51	.23
A x B x C	.64	2	.32	.15
Error	184.87	84	2.20	

**$p < .01$

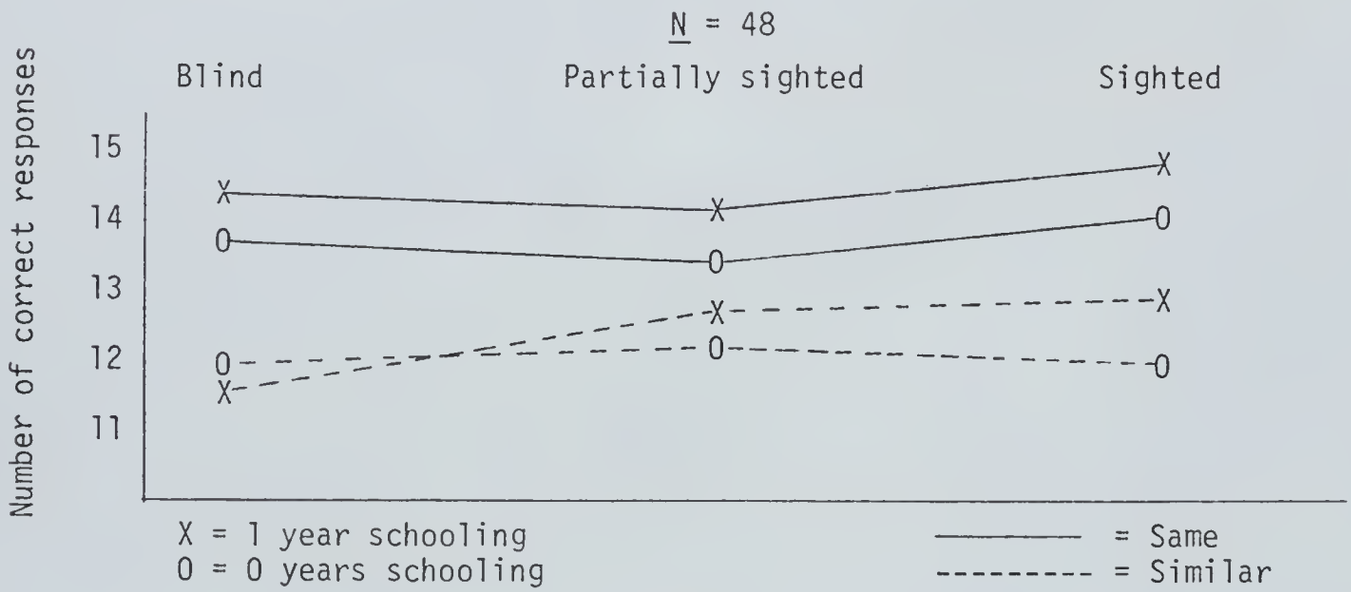

Figure 2

Mean Performance for Identification on the Basis of Amount of Vision and Amount of School Experience (Maximum Score = 15)

The next ANOVA performed examined the relationships among the variables of degree of vision, amount of school experience, and the individual room categories. However, it was found that in reducing the length of HOFA, scores for the room category were not equivalent. Therefore, only tentative conclusions may be drawn from this analysis (Table 6). (Total maximum scores available for each room category were the following: utility = 6, living = 5,

bath = 5, kitchen = 4, bedroom = 6, playroom = 4). Despite the inequivalence of the room scores, a strong significant difference was obtained. Interpreting this conservatively would still suggest that young children whether visually impaired or not, do recognize objects tactually from some parts of a house more readily than other areas. With corrected scores the difference on the basis of schooling would probably not exist suggesting that school experience does not contribute significantly to the young child's development of tactual recognition skills in the home.

Table 6

ANOVA on Mean Total Correct Responses for Room Categories on HOFA
N=48

Source	SS	df	MS	F
Vision (A)	1.50	2	.75	1.36
Schooling (B)	2.17	1	2.17	3.90*
Rooms (C)	222.60	5	44.52	80.06**
	.76	2	.38	.68
	7.20	10	.72	1.30
	2.60	5	.52	.94
	4.78	10	.48	.86
Error	140.12	252	.56	

* $p < .05$
** $p < .01$

The final ANOVA examined the differences in performance of young children's tactual recognition of household objects on the basis of degree of vision, amount of school experience, and familiarity of the objects as previously rated by parent volunteers. Surprisingly, the youngsters disproved the parent ratings in general because no significant differences were found on the basis of familiarity (Table 7).

Table 7

ANOVA on Mean Total Correct Responses for Familiarity Ratings on HOFA
N=48

Source	SS	df	MS	F
Vision (A)	3.01	2	1.51	1.20
Schooling (B)	4.34	1	4.34	3.44
Familiarity (C)	6.89	2	3.44	2.73
A x B	1.51	2	.76	.60
A x C	5.15	4	1.29	1.02
B x C	1.05	2	.53	.42
A x B x C	1.65	4	.41	.33
Error	158.87	126	1.26	

Item difficulty was examined by obtaining the percentage correct for each question (Table 8). In general, all subjects performed well and few differences were noted among vision categories. For instance, difficult questions (e.g., Part B # 23) proved difficult for all vision categories.

Table 8

Percentage Correct for Each Item by Room Categories

Room & Item Number	Blind	Partially Sighted	Sighted
Utility			
1(F)	100	94	100
7(UF)	87.5	81	94
10(VF)	100	100	100
17(UF)	81	100	81
21(F)	87.5	100	94
22(VF)	44	37.5	75
Living			
2(F)	75	100	94
14(VF)	94	87.5	87.5
26(VF)	94	100	94
28(F)	81	100	94
29(UF)	62.5	56	69
Bath			
3(F)	100	100	94
6(UF)	87.5	87.5	87.5
8(VF)	94	100	100
16(F)	100	100	94
20(VF)	81	94	100

Table 8 (Con't.)

Percentage Correct for Each Item by Room Categories

Room & item number	Blind	Partially sighted	Sighted
Kitchen			
4(VF)	100	94	100
5(UF)	94	94	100
23(F)	19	31	6
24(UF)	81	75	75
Bedroom			
9(VF)	81	81	94
12(F)	94	62.5	94
15(UF)	100	87.5	100
19(VF)	94	81	94
27(F)	94	94	100
30(VF)	94	100	100
Playroom			
11(VF)	100	100	100
13(F)	94	100	100
18(UF)	75	69	62.5
25(VF)	87.5	100	100

(VF = Very familiar, F = Familiar, UF = Unfamiliar)

When familiarity over all groups was examined a slight trend was noted from very familiar (90.65%) to familiar (86.53%) finally to unfamiliar (85.45%), but the trend was not as strong as would have been anticipated by the parents' ratings.

Incorrect responses were then studied to determine whether subjects more often chose the second option (object in the next closest ranked order) or the third option (object from list which could be associated with the object or in some way might be tactually confusable with it) (Table 9). Although little difference was seen between options chosen by sighted or partially sighted children, blind children tended to choose the third option (object associated or tactually confusable with stimulus) more frequently than the second option.

Table 9

Number of Incorrect Options Chosen by all Subjects and by Item Number

Item number	Option 2			Option 3		
	B	PS	S	B	PS	S
1					1	
2				4		1
3			1			
4		1				
5				1	1	
6				2	2	2
7		2	1	3	1	
8	1					
9	2	1		1	2	1
10						
11						
12		3		1	3	1
13				1		
14	1	1			1	2
15		3				
16			1			
17			1	3		2
18	1	1		3	4	6
19				1	3	1
20	2	1		1		
21	2		1			
22	6	9	3	3	1	1
23	13	11	15			
24		1		1	3	4
25				2		
26				1		1
27		1		1		
28			1	3		
29				6	7	4
30				1		
	28	35	24	39	29	26

As may be seen in Table 10, blind subjects more frequently assigned a verbal label to the incorrect choices than did their partially sighted or sighted peers.

Table 10

Verbal Labels Assigned to Incorrect Options by Each Subsample
N=48

Item number	Option 2			Option 3		
	B	PS	S	B	PS	S
1 Spool of thread					1-thread	
2 Magazine				1- 3-book		
3 Bandaid			1-tongue depresser			
4 Cookie		1-				
5 Funnel				1-bell	1-	
6 Tub brush				1-brush	2-	1- 1-like little broom
7 Dust brush		2-	1-	1- 1-sugar donut 1 brush	1-	
8 Soap	1-soap					
9 Sock	2-	1-		1-	1- 1-glove	1-
10 Flashlight						
11 Truck						
12 Zipper		3-		1-	1- 2-belt	1-
13 Record				1-		
14 Extension cord	1-	1-cord			1-rope	2-
15 Nail polish		2- 1-medicine				
16 Bristle toilet brush			1-			
17 Round pincushion			1-ball	1- 1-apple 1 thing you put needles in		2-
18 Grooved bead	1-	1-		3-	2- 1-sock 1-bead	4- 1-feels like marble 1-like a cupcake
19 Shoe				1-	3-	1-shoe
20 Adult toothbrush	2-	1-		1-toothbrush		
21 Long screw	2-		1-nail			
22 Course string	3- 3-string	6- 1-yarn 1-rope 1-string	1- 2-string	2- 1-string	1-	1-string
23 Round saltshaker	1-bottle 1-glass 1-salt shaker	1-perfume 1-can 1-bottle	1-feels like shaver thing 1-glass			

Table 10 (Con't.)

Verbal Labels Assigned to Incorrect Options by Each Subsample
N=48

Item number	Option 2			Option 3		
	B	PS	S	B	PS	S
23 Round saltshaker (con't.)	1-makeup 1-medicine jar 1-jar 1-shaker 1-cup 1-perfume 4-	1-playdough 1-saltshaker 6-	1-bottle 1-salt 1-spray bottle 10-			
24 Large cork		1-		1-feels like meat	3-	4-
25 Large ball				1-small ring 1-ball		
26 Covered doorknob				1-		1-
27 Dress		1-		1-shirt		
28 Glass ashtray			1-	1-cup 2-ashtray		
29 Thin phonebook				1- 1-paper 4-book	3- 4-book	3- 1-book
30 Small powderpuff				1-		

The means and standard deviations for each subsample for total correct responses on the TSA are presented in Table 11.

Table 11

Total Correct Responses by Subsample on TSA

		0 yrs. schooling ages 4 to 7 years		1 yr. schooling ages 4 to 7 years		Total by vision	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Blind	M	17.00	4.97	20.00	1.41	17.68	4.54
	F	20.25	1.25	13.50	5.92		
Partially sighted	M	15.50	4.51	22.25	1.26	18.40	3.61
	F	17.50	2.64	18.50	2.08		
Sighted	M	16.25	1.26	20.25	3.09	18.25	3.96
	F	13.75	1.50	22.75	.50		
Total by schooling		16.70	3.41	19.54	4.07		
Total by	M	18.54	3.74				
	F	17.70	4.25				

As may be observed, all subsamples did relatively well in tactual recognition of shapes (maximum score attainable for Parts A and B = 24). Little difference is seen among subsamples on the basis of vision, but amount of previous schooling indicates a trend supported in the statistical analyses. Differences among sexes are noted but seem to contradict between subsamples.

A 3 x 2 x 2 analysis of variance was performed on the total correct responses obtained on TSA (Table 12). As noted above, no significant differences were found for the main effects of vision or sex, but those who had 1 year of formal school experience performed significantly better than those with no previous experience. However, a significant interaction was found between degree of vision and amount of schooling. This might be explained in part by the low mean obtained by blind female subjects with 1 year of schooling in comparison with their counterparts' mean with no previous schooling, while all other subsamples improved with one year of schooling. The significant interaction effect of all three variables was barely attained and may again be attributed to the irregular performance of the blind female group with 1 year of previous schooling and to the small number of subjects per cell (n=4).

Table 12

ANOVA on Mean Total Correct Responses on TSA
N-48

Source	SS	df	MS	F
Vision (A)	3.29	2	1.65	.16
Schooling (B)	102.08	1	102.08	10.22**
Sex (C)	6.75	1	6.75	.68
	137.54	2	68.77	6.89**
	3.87	2	1.98	.19
	33.33	1	33.33	3.34
	110.29	2	55.15	5.52**
Error	359.50	36	9.99	

**$p < .01$

Relative difficulty was determined by compiling the number of successes obtained for each shape by vision categories and by school experience groupings (Tables 13 and 14).

Table 13

Total Correct Responses for Each Shape by Subsamples for Part A of TSA

		N=8 0 years schooling ages 4 to 7 years												N=8 1 year schooling ages 4 to 7 years									
Item number		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Blind	M	4	2	2	2	3	2	4	3	4	2	3	3	4	4	4	3	4	1	4	4	4	4	3
	F	3/7	2/4	1/3	3/5	4/7	4/6	4/8	4/7	3/7	3/5	4/7	4/7	2/6	2/6	3/7	2/5	3/7	2/3	4/8	2/6	3/7	2/6	2/5
Partially sighted	M	3	3	1	2	2	3	2	3	3	2	3	3	3	4	3	4	4	4	4	4	4	4	4
	F	4/7	2/5	3/4	4/6	4/6	2/5	-/2	3/6	3/6	3/5	3/6	4/7	3/6	4/8	1/4	2/6	3/7	4/8	4/8	4/8	2/6	3/7	3/7
Sighted	M	1	2	2	1	4	4	4	2	3	4	4	3	3	2	2	2	4	4	4	4	4	4	4
	F	3/4	4/6	-/2	2/3	2/6	4/8	3/7	2/4	4/7	2/6	1/5	2/5	4/7	4/6	4/6	3/5	4/8	4/8	4/8	4/8	4/8	4/8	4/8
Total		18	15	9	14	19	19	17	17	20	16	18	19	19	20	17	16	22	19	24	22	21	21	20

Table 14

Total Correct Responses for Each Shape by Subsamples for Part B of TSA

		N=8 0 years schooling ages 4 to 7 years												N=8 1 year schooling ages 4 to 7 years									
Item number		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Blind	M	3	2	3	4	3	3	2	1	3	2	4	4	3	2	3	4	3	4	4	2	2	3	4
	F	4/7	2/4	4/7	3/7	4/7	3/6	4/6	3/4	3/6	4/6	4/8	4/8	2/5	1/3	2/5	2/6	4/7	1/5	2/6	1/3	3/5	3/6	1/5
Partially sighted	M	2	2	2	1	4	2	4	3	2	3	4	3	4	3	4	4	4	4	4	1	3	4	4
	F	4/6	2/4	4/6	4/5	3/7	1/3	4/8	2/5	2/4	2/5	4/8	3/6	2/6	2/5	3/7	3/7	4/8	3/7	3/7	2/3	4/7	3/7	4/8
Sighted	M	2	2	4	3	3	2	3	-	2	3	4	3	4	4	4	3	4	4	3	2	1	4	4
	F	1/3	-/2	4/8	3/6	2/5	1/3	3/6	2/2	2/4	2/5	3/7	3/6	4/8	3/7	4/8	4/7	4/8	4/8	4/7	2/4	4/5	4/8	3/7
Total		16	10	21	18	19	12	20	11	14	16	23	20	19	15	20	20	23	20	20	10	17	21	20

Table 15 depicts the items by order of difficulty. Part A, containing the simpler shapes typified by topological differences indicated a difference between the correct responses of subjects with no previous schooling and those with 1 year of schooling. However, Part B which includes both topological and Euclidian features does not indicate such a discrepancy between the two school experience groups.

Comparison of the order of difficulty for the present subsamples with the Larendeau and Pinard (1970) study is found in Table 16.

Table 15

Items Arranged in Order of Difficulty

PART A	0 years schooling	item number	3	4	2	10	7	8	1	11	5	6	12	9
		number of correct responses	9	14	15	16	17	17	18	18	19	19	19	20
	1 year schooling	item number	4	3	1	6	2	11	9	10	12	5	8	7
		number of correct responses	16	17	19	19	20	20	21	21	21	22	22	24
PART B	0 years schooling	item number	2	8	6	9	1	10	4	5	7	12	3	11
		number of correct responses	10	11	12	14	16	16	18	19	20	20	21	23
	1 year schooling	item number	8	2	9	1	3	4	6	7	11	10	5	12
		number of correct responses	10	15	17	19	20	20	20	20	20	21	23	24

Table 16

Relative Difficulty of Items for Present Subsamples Compared with the Larendeau and Pinard Sample (1970)

Variable = Item Number

	Larendeau & Pinard	Blind 0 year	Blind 1 year	Partially sighted 0 year	Partially sighted 1 year	Sighted 0 year	Sighted 1 year
	Part A						
	4	3	6	7	3	3	4
	8	2	4	3	1	4	2
Hardest	2	4	11	2	4	1	3
	12	10	1	6	9	8	1
	1	6	2	10	5	11	12
	6	1	8	4	10	12	5
	3	5	10	5	11	2	6
	11	8	12	8	2	5	7
	9	9	3	9	6	10	8
	10	11	5	11	7	7	9
Easiest	5	12	9	1	8	9	10
	7	7	7	12	12	6	11
	Part B						
	6	2	2	6	8	2	8
Hardest	2	8	8	2	2	8	9
	8	6	1	9	1	1	2
	4	7	3	4	3	6	4
	9	9	6	8	4	9	7
	10	10	9	10	6	5	11
	1	1	11	1	7	10	1
	5	3	4	3	9	4	3
	3	4	7	12	10	7	5
Easiest	7	5	10	5	5	12	6
	12	11	5	7	11	11	10
	11	12	12	11	12	3	12

An attempt to examine incorrect responses by vision categories and amount of school experience is found in Tables 17 and 18. Option 2, defined as a topologically similar shape, was chosen more frequently by all subsamples than either options 3 or 4. In examining total errors, blind subjects with no previous schooling made fewer errors than either the partially sighted or sighted subjects. However, after 1 year of schooling, the blind subjects made more errors than either of the two subsamples with the sighted having the fewest errors.

Table 17

Number of Incorrect Options Chosen by Vision and Schooling Subsamples for Part A

	0 years schooling									1 year schooling								
Item number	Option 2			Option 3			Option 4			Option 2			Option 3			Option 4		
	B	PS	S	B	PS	S	B	PS	S	B	PS	S	B	PS	S	B	PS	S
1		1	2	1		2				1	1		1	1				1
2	3	2	2				1	1				2	2					
3	4	4	5	1					1	1	3	2		1				1
4	3	1	4			1		1		3	2	3						
5	1				1	1		1	1		1					1		1
6	1	1			1		1	1		2			2			1		
7		4				1		2										
8	1	2	2			2				1			1					
9	2	1			1	1				1				2				
10	1	1	1	2	2	1				1	1		1					
11		1	3				1	1		1	1		1			1		
12	1	1	3							1			1					1
Totals	17	19	22	4	5	9	3	7	2	12	9	7	9	4	0	3	0	4

Table 18

Number of Incorrect Options Chosen by Vision and Schooling Subsamples for Part B

	0 years schooling									1 year schooling								
Item number	Option 2			Option 3			Option 4			Option 2			Option 3			Option 4		
	B	PS	S	B	PS	S	B	PS	S	B	PS	S	B	PS	S	B	PS	S
1	1		3			2		2		1			1				2	
2	2	1	1	1	1	1	1	2	4	3	3	1	1			1		
3		1					1	1		2			1				1	
4	1	2				1		1	1	2	1	1						
5	1		1		1	2							1					
6	1	4	2		1	2	1		4	3	1							
7	1		2				1				1	1	1			1		
8	2	2	4	1	1	2	1			4	3	3		2	1			
9	2	3	4		1					3	1	3						
10	1		1		3	2	1				1		1			1		
11			1							1		1	1			1		
12		1	1		1				1									
Totals	12	14	20	2	9	12	6	6	10	19	11	10	7	2	1	4	3	0

A cursory examination of the effects of verbal labels may be obtained in Tables 19 and 20. Children making errors provided verbal labels less frequently than those who chose correct options. Again, the caution must be stated that subjects were not required to provide verbal labels, but when spontaneously given were recorded. Therefore, this data is presented solely for the reader's interest and information, not for defining any conclusions.

Table 19

Verbal Labels by Vision Categories for Each Incorrect Option of TSA-Part A

Item number	Option 2			Option 3			Option 4		
	B	PS	S	B	PS	S	B	PS	S
1	1-round shape	2-	2-	2-	1-star	2-			1-
2	2- 1-cross	1- 1-cross	4-	2-			1-	1-	
3	2- 1-Valentine heart 1-oval 1-piece of puzzle	4- 3-circle	6- 1-round circle with hole in it	1-	1-round circle with hole in it				1-
4	2- 1-round 1-triangle 1-hectigon 1-circle shape	1- 1-an "X" 1-star	6- 1-an "X"			1-piece of puzzle		1-	
5	1-	1-			1-	1-	1-container	1-	1-
6	1- 1-circle 1-2 holes in the middle	1-		2-	1-		1- 1-circle shape	1-	
7		3- 1-circle				1-		2-	
8	1- 1-round shape	2-	1- 1-rectangle	1-		2-			
9	1-donut hole 1- 1-square shape	1-			1- 1-bracelet 1-part of a man	1-			
10	1- 1-circle	1-"A" 1-	1-circle with no cross on side	1-circle 1-triangle shape 1-corn	2-	1-			
11	1-	1- 1-square	2- 1-rectangle	1-circle shape			2-	1-	
12	1-thingie 1-	1-	3-	1-					1-

Table XII

Verbal Labels by Vision Categories for Each Incorrect Option of TSA - Part B

Item Number	Option 2			Option 3			Option 4		
	B	PS	S	B	PS	S	B	PS	S
1	2-		1-triangle 1-block 1-rectangle	1-		2-	1-a round shape	2- 1-rectangle 1-square	
2	1- 1-rectangle 1-diamond 1-diamond shape, almost 1-square shape	1-square 1-triangle 2-	1-rectangle 2-triangles 1-	2-square	1-	1-feels like a square	1- 1-triangle	2-	1-triangle 3-
3	1- 1-triangle	1-		1-			1-	2-	
4	1- 1-star 1-circle shape	2- 1-star	1-			1-triangle		1-	1-
5	1-		1-	1-	1-square	1- 1-piece of big cookie			
6	2- 1-chair 1-square shape	3- 2-square	1- 1-another piece of cookie		1-	2-	1-rectangle		1-
7	1-circle	1-	1-feels like bird 1-fat circle 1-circle	1- 1-triangle shape			1-pop 1-		
8	2- 1-circle shape 1-the pop 1-puzzle shape 1-rectangle	3- 1-sailboat 1-elephant	5- 1-triangle 1-something like a square	1-chair	2- 1-square	1- 1-triangle 1-four sides, don't know what it is	1-triangle		
9	2- 1-triangle 1-cross 1-"X"	2- 1-boy 1-cross	3- 1-star 1-boy 1-rectangle 1-cross		1-				
10	1-triangle	1-	1-	1-"X"	1- 1-boy 1-another star	1- 1-circle with holes in it	2-		
11	1-circle		1- 1-circle	1-			1-triangle shape		
12		1-	1-		1-				1-

Discussion

Although few substantial inferences may be made from the data due to the small sample size (n=4 per cell), some conclusions may tentatively suggest further avenues of research. Unlike previous studies (Mitchelmore, 1976; Taback, 1975) in which differences were found between male and female performances on spatial tasks, no differences were found among the present subjects (Tables 4 and 14) for either objects or shapes. These differences found previously may be in part due to the older ages of subjects used in both Taback's (1975) and Mitchelmore's (1976) studies as well as the types of tasks used. The difference between sexes may develop as the child moves into concrete operations and attempts to manipulate spatial constructs. This conclusion is suggested by the significant difference found in form of identification for HOFA. Finding the same object as the stimulus required simple tactual recognition. However, to identify an object similar to the stimulus required not only tactual recognition of the entire object, but analysis of its primary components which would be found in the correct alternative. The requirement to analyze the object and hold particular components constant while inspecting and locating those components on one of three alternatives requiring greater mental manipulation resulted in a significantly different performance from that of Part A (Witkin, Birnbaum, Lomonaco, & Herman, 1968).

The data also tended to support the results of other researchers (Ahmad, 1971; Ewart & Carp, 1963; Worchel, 1951) who found little difference among groups on the basis of amount of vision when only tactual recognition was required. Since neither the HOFA or TSA required skills other than tactual recognition, no differences were found between vision groups (Tables 4 and 12).

Only on TSA was schooling significantly different. This suggests that the objects used in HOFA were simple and very familiar to all children whether they had been in school previously or not. The means for each group (Table 3) support this conclusion since all means are near the maximum available score.

The significant difference found among the room categories (Table 6), though it must be interpreted cautiously, does confirm the original hypothesis that young children would be more familiar with objects in some rooms rather than others because of safety precautions. For instance, the playroom would probably produce more correct responses than the kitchen where exploration would be inhibited for safety considerations. The significant difference on schooling would support this conclusion also since a child with a year of schooling would be older and probably would be given greater freedom in the home.

When HOFA was examined on the basis of familiarity of items (Table 7), no significant differences were found. Although 15 volunteer parents (10 of sighted, 5 of visually impaired children) rated the objects on the basis of familiarity to preschool children, the subjects rated all items equivalently suggesting greater familiarity with objects in their environments than anticipated by parents of preschoolers. Since preschooler had not been defined in terms of age for the parents, they may have assumed a younger age than that represented in the sample. However, even the youngest blind child with no previous school experience surpassed the expected ratings of these parents. In examining the percentage correct for each item (Table 8), it is interesting to note that for both the partially sighted and sighted samples the most difficult room category was the kitchen while for the blind sample it was the utility room. The highest correct percentage

for the blind, however, was the bedroom where many young blind children may still spend much of their time playing. For both the partially sighted and sighted samples the highest correct percentage was found for the bathroom. As noted previously, a slight trend from very familiar to unfamiliar was noted, but the differences were nonsignificant (Very Familiar - 90.65%; Familiar - 86.53%; Unfamiliar - 85.45%).

When incorrect responses were analyzed (Table 9), the blind tended to choose the object most associated with or tactually confusable with the stimulus. The partially sighted and sighted groups, however, indicated no preference for either option 2 or 3. This might suggest that the blind were attempting to form some type of primitive classification rather than identify a specific object with the same function as the stimulus (Tobin, 1972).

Although subjects were not required to give verbal labels to each item, many children spontaneously named the object when they recognized it tactually. These names were recorded and are summarized for incorrect responses only in Table 10. More children choosing the correct option named the stimulus than those who made incorrect responses. Frequently, children who did not name the stimulus made an incorrect response. This may suggest that the ability to recognize and give a verbal label to the stimulus encouraged correct responses while lack of verbal labels or incorrect naming inhibited correct responses. In contrast, blind children provided more names for the stimulus when making incorrect responses than other groups. However, these conclusions must be considered extremely tentative since verbal labeling was not required of the subjects and was a serendipitous variable considered only at the conclusion of the study. The data is presented solely for the reader's interest.

The TSA involved more abstract forms for tactual recognition than the HOFA, yet means of the subsamples reveal few differences on the basis of amount of vision or sex (Table 11). These findings are substantiated by the analysis of variance (Table 12) which did indicate a significant difference, however, on the basis of schooling. This might be attributable to the teachings during the first year of school which frequently emphasize shapes (i.e., circle, square, triangle). The significant interaction noted between amount of vision and schooling, although primarily due to the schooling effect, is influenced by the strange performance of the blind females who performed extremely better without school experience than with it. This in conjunction with the sizable difference in standard deviations within the groups for the females with 1 year of schooling contributed to this interaction. The interaction of all three main effects barely met the significance level and must be attributed to the strong influence of previous school experience as well as the above mentioned causes.

The relative difficulty of Parts A and B of TSA (Tables 13 and 14) suggest that few of the shapes were of great difficulty for any of the subsamples for Part A though Part B did create some greater obstacles. The advent of Sesame Street and other programs, early school training, and other influences may be partially responsible for the greater tactual recognition of shapes by all groups.

In Table 16 the mean number of successes for ages 4 through 7 years was obtained for each item from the study by Larendeau and Pinard (1970, p. 50). These means were then used to rank the order of items in terms of difficulty from hardest to simplest. For comparison, the mean successes for each item for the present subsamples were also used to rank the items from most difficult to least difficult. As may be noted, there

were some similarities between the performances of the present subjects and those of Larendeau and Pinard (1970). The irregular cross and Greek cross presented the most difficulty for all groups (appearing in the highest third of the ranking), while circle and open ring were the least perplexing on Part A. In Part B the trapezoid and irregular quadrilateral presented the most problem for all groups while the circle and rectangle seemed the easiest (appearing in the lowest third of the ranking). These similarities persisted between vision groups with no previous school experience as well as those with 1 year of schooling.

When the vision categories were collapsed some differences in order of difficulty did appear between subjects with no previous schooling and those with 1 year of schooling (Table 15). On Part A the difficult items remained relatively the same but the simplest items differed. It may be seen that for those with 1 year of school experience, circle, square, and triangle were found the simplest on Part A. But those with no previous schooling found the open ring, open rectangle, and the disk with two holes the easiest. The latter figures would support the conclusions of Piaget and Inhelder (1956) since these are all characteristically topological figures while those for the other sample involve curvilinear-rectilinear relationships. For Part B the subjects with no previous schooling now found the circle, triangle, and rectangle the easiest representing curvilinear-rectilinear relationships. However, the subjects with 1 year of schooling found the rectangle, square, and Maltese cross the simplest. These shapes represented a finer distinction of the curvilinear-rectilinear relationship (square and rectangle) as well as some beginning understandings of Euclidian concepts. These findings would seem to agree with the conclusions of Larendeau and Pinard (1970). They state that the distinction of curvilinear-rectilinear

shapes derives from Euclidian geometry but that Piaget hypothesized that the distinction is the first formed in the child who already discriminates topological relations. In his study Lovell (1959) found that the identification of curvilinear shapes was not much more difficult than that of topological shapes. However, discrimination of various rectilinear shapes was found to be more complex and appeared later. The results here would seem to confirm the conclusions of these previous studies that topological and curvilinear-rectilinear relationships precede understandings of Euclidian concepts.

When incorrect options chosen were examined (Tables 17 and 18), the results indicated that for all vision categories and for both types of school experience, option 2 (defined as a topologically similar shape) was chosen more frequently than either of the other options. This would tend to support the idea that topological relationships strongly influence the early distinctions young children make. The fact that there were no differences among vision groups is encouraging.

As with HOFA, verbal labels spontaneously given by the subjects were recorded. Although not required, many children did attempt to name the stimulus shape. These names are presented for Part A (Table 19) and for Part B (Table 20) for each option by vision category. Again no firm conclusions can be inferred from these data, but of interest is the fact that blind children again spontaneously provided verbal labels more frequently than their peers. These data are presented solely for the interest of the reader.

In summary, although performance on HOFA provided less dispersion than had been expected, it was found that finding an object similar to

the stimulus required greater mental manipulation than finding the same object. While Swallow (1973) felt that acting on objects became the foundation for spatial learning, Davidson (1972) stated that the amount of active handling of an object was critical to the development of accurate judgments of form perception. Citing Gibson, Davidson (1972) affirmed that active handling isolated and enhanced the components of stimulation which specified the shape and other characteristics being touched. He found that 4 to 5 year old subjects typically involved little examination of a form's contour, but 6 to 7 year olds were more accurate. The latter simultaneously grasped the whole figure with all fingers of the hand, isolating leading features of the form and appearing to compare it with all other aspects of the form. Therefore, it was concluded that global or simultaneous exploration was a particular aspect of active handling that bore upon the accuracy in judging the form. An important role of scanning involved the accurate coding of stimulus information for later use and Davidson (1972) felt that exploratory activity could be modified by experience. Since Witkin et al. (1968) had found that blind children tend to be more global in their cognitive patterning, the blind child may need to be taught early how to investigate objects actively. He may need to be taught how to trace edges and how to feel the entire surface in order to construct any image at all (Swallow, 1973; Swallow & Poulsen, 1972). Although it had been planned originally that data on exploratory techniques would be gathered for the various subsamples, the time and energy necessary for administration of the assessments, did not permit the inclusion of this variable. However, it may be inferred, as Davidson (1972) suggests that experience develops exploratory techniques since those with 1 year of schooling in general surpassed those with no previous schooling. The role of coding stimulus information may also be inferred from the significant difference found between

the identification of the same and that of the similar items.

The differences between rooms, though it must be interpreted cautiously, suggest that young children are more familiar with particular rooms of the house than others. In this sense, a readiness assessment might include some of these items to determine children whose experiential background might inhibit their progress in formal school programs. Tobin (1972) stated that the school is left with the task of identifying the experientially underprivileged when they arrive at school and then of providing appropriate compensatory stimulation. Again further study of this area might provide a means for identifying these experientially underpriviledged children.

Finally, the fact that there was no difference on the basis of familiarity suggests that a wider range of objects might be useful. Common objects from the home may indicate for the visually impaired child the extent of freedom the preschool child has had to explore and become acquainted with his environment. Linked with verbal labeling, it could prove an asset in determining the child's readiness for and placement in educational programs.

The results from the TSA prove especially interesting because no differences were found among the vision categories or between the sexes. Since this was a tactual recognition assessment, the lack of difference among vision categories added weight to the conclusions of other researchers (Ahmad, 1971; Ewart & Carp, 1963; Worchel, 1951). But the lack of difference also indicated that blind children as well as sighted children proceed in their early spatial development similarly. That is, performance showed that the simplest of all forms were those with topological and curvilinear-rectilinear relationships while forms with Euclidian characteristics proved the most difficult (Larendeau & Pinard, 1970; Lovell, 1959; Piaget & Inhelder, 1956).

We might conclude then that if development of elementary spatial concepts proceeds similarly, any differences that are found may be due to other variables. One not explored here was age. But Larendeau's and Pinard's (1970) study did find a developmental trend based on age. Other variables might include IQ and/or socioeconomic level (Bass, 1975). However, one variable of especial import for visually impaired youngsters would be the effect of early training on active handling. Some of the more primitive means of tactual exploration such as pressing the fingers against an edge, shifting the hand back and forth along an edge, pinching the form between the fingers was observed among blind children. Early training in exploratory techniques as suggested by various authors (Swallow, 1973; Swallow & Poulsen, 1972; Tobin, 1972) could be useful in training young blind children to isolate distinctive components, discriminate likenesses and differences, and provide a means for mental reconstruction of the stimulus. The effects of this early training, if successful, could influence later performance in spatial areas of life functioning including such things as orientation, mobility, and map reading and interpretation.

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Household Objects Familiarity Assessment

Part A - Item in left column is felt and identical item found among three choices in the columns to the right.

1.	spool of thread	course string	spool of thread	hammer
2.	magazine	magazine	newspaper	footstool
3.	bandaid	washcloth	bandaid	q-tip
4.	cookie	glass	lollipop	cookie
5.	funnel	cleanser	glass	funnel
6.	tub brush	toilet brush	tub brush	medicine dropper
7.	dustbrush	battery	dustbrush	knitting needle
8.	soap	toothpaste	soap	washcloth
9.	sock	shoe	eyeglasses	sock
10.	flashlight	battery	box	flashlight
11.	truck	balloon	wheel	truck
12.	zipper	nailfile	zipper	belt
13.	record	wheel	record	toy camera
14.	extension cord	rope	flower pot	extension cord
15.	nailpolish	eyeglasses	nail clipper	nailpolish

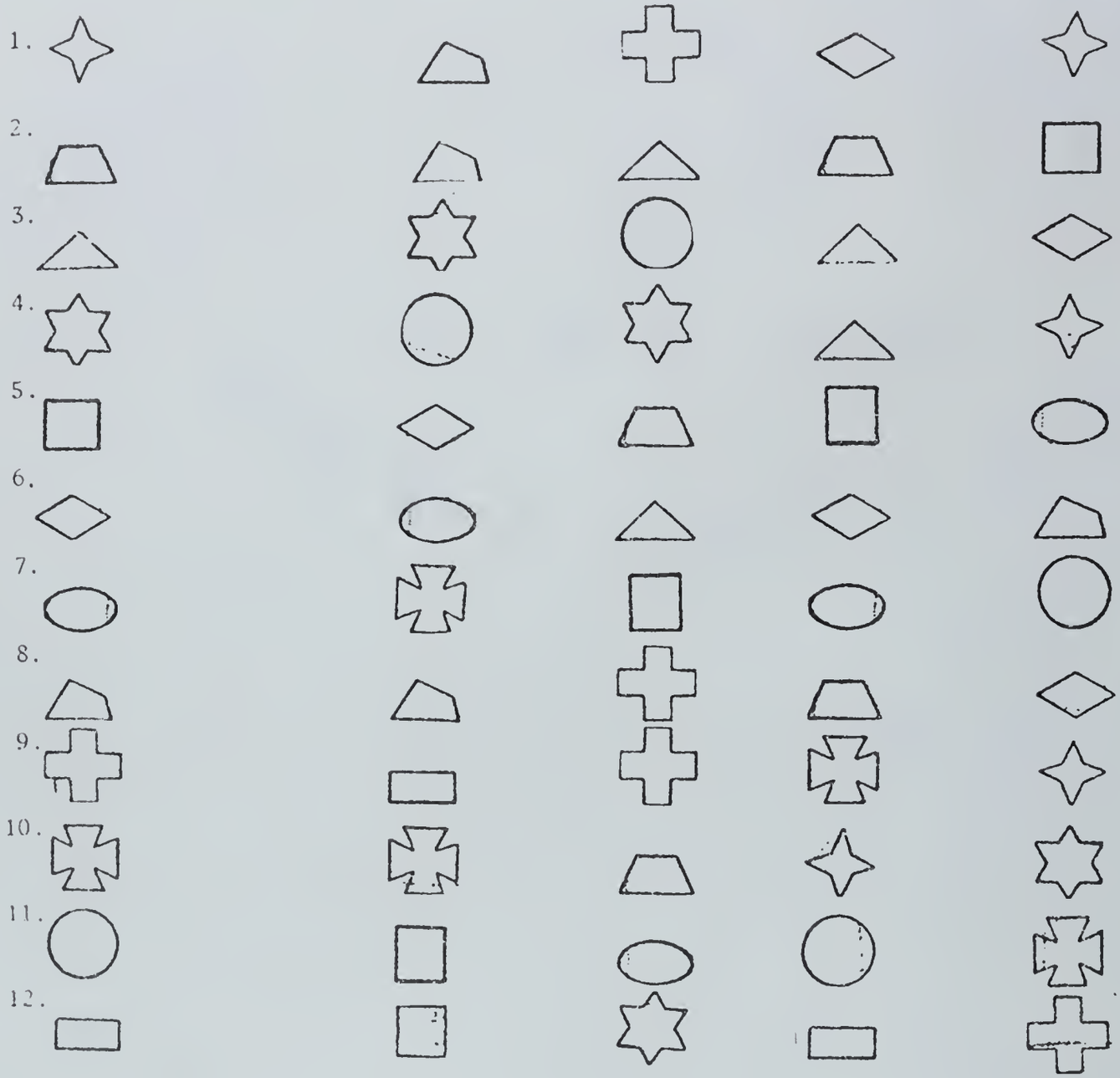
Household Objects Familiarity Assessment

Part B - Item in left column is felt and a similar item is found among the three choices in the columns to the right.

16.	bristle toilet brush	cleanser	sponge	rubber toilet brush
17.	round pincushion	pliers	box	wrist pincushion
18.	grooved bead	marble	paintbrush (bristle towards)	smooth bead
19.	shoe	slipper	sneaker shoe	pants
20.	adult toothbrush	toothpaste	comb	child's toothbrush
21.	long screw	short screw	clothespin	hammer
22.	course string	smooth string	spool of thread	rope
23.	round saltshaker	walnut	square saltshaker	jar
24.	large cork	candle	walnut	small cork
25.	large ball	block	jacks	small ball
26.	covered doorknob	coin	throw pillow	doorknob
27.	dress	powder	zipper	sun dress
28.	glass ashtray	plastic ashtray	newspaper	flowerpot
29.	thin phonebook	flowervase	thick phonebook	book
30.	small powderpuff	nailfile	powder	large powderpuff

Topological Shapes Assessment

Part A - Item in left column is felt and an identical item is found among the four choices in the columns to the right.

Topological Shapes Assessment

Part B - Item in left column is felt and an identical item is found among the four choices in the columns to the right.